TAXONOMY AND ECOLOGY OF *JURANOMIA CALCIBYSSATA* GEN. ET SP. NOV.- A WIDESPREAD ANOMIID BIVALVE FROM THE UPPER JURASSIC OF PORTUGAL

by

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ABSTRACT

Juranomia calcibyssata gen. et sp. nov. is a typical anomiid bivalve characterized by a byssal notch and crus supporting the ligament in the lower, right valve and by three interconnected muscle scars in the upper, left valve. The shells are fixed to the substrate by means of a calcified byssus. The species is abundant in marginal marine (brackish) environments of the Lusitanian Basin of Portugal during Kimmeridgian times.

RÉSUMÉ

Juranomia calcibyssata est un représentant typique de la famille des Anomiidae (Bivalvia), caractérisé par sa valve inférieure (droite) avec une encoche byssale et un crus supportant le ligament et par sa valve supérieure (gauche) avec trois impressions musculaires centrales réunies. L'espèce est fixée au substrat par une cheville calcaire byssale. Elle est très abondante dans les couches à faciès marginal (saumâtre) du Kimméridgien du Bassin Lusitanien (Portugal).

KEY-WORDS : JURASSIC, BIVALVIA, TAXONOMY, NEW TAXA, PALAEOECOLOGY, PORTUGAL.

MOTS-CLÉS : JURASSIQUE, BIVALVIA, TAXONS NOUVEAUX, PALÉOÉCOLOGIE, PORTUGAL.

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I - INTRODUCTION

Anomiid bivalves are frequently mentioned in monographs on Jurassic molluscs (e.g. Buvignier 1852, Contejean 1860, Loriol & Pellat 1866,1875, Quenstedt 1856), their most diagnostic feature being a more or less circular hole near the umbo of the flat valve. Nearly invariably, however, subsequent investigations proved this hole to be an artefact caused by abrasion of the umbonal region (e.g. Morris & Lycett 1853, p. 6 ; Arkell 1929, p. 49 ; Freneix *et alii* 1986) and most forms were subsequently transferred from *Anomia* to *Placunopsis* (e.g. Fürsich 1981, Freneix *et alii* 1986) (the latter genus lacking the byssal notch and other internal features characteristic of anomiids). Only *Anomia foliacea* ETALLON (Thurmann & Etallon 1863, p. 281, pl. 40, fig. 5) might be a true anomiid. The species is known from a single articulated specimen with a hole, which might represent a byssal foramen, in the umbonal region of the concave valve. The Jurassic occurrence of anomiid bivalves was therefore ill-founded, until Fürsich & Palmer (1982) described an undoubted anomiid, *Eonomia timida,* from the Upper Bathonian and Oxfordian of England and Normandy. Only the lower (right) valve of this species is well known. It exhibits a distinct byssal notch and crura typical of anomiids. A calcified byssus, present in Recent anomiids, apparently is lacking ; instead, the lower valve is cemented to hard substrates.

The aim of this paper is to describe another true anomiid from Jurassic rocks, whose widespread occurrence indicates that the family Anomiidae was well represented by late Jurassic times.

II - MATERIAL

More than 300 left valves, 5 right valves and several articulated specimens from the Kimmeridgian of the Lusitanian Basin of central Portugal (Estremadura) were available for study. Most valves occur isolated in marly to silty clays. Articulated specimens are attached to large shells such as *Isognomon*, *Myophorella*, and *Gervillia*. Right (lower) valves could be only observed by removing the upper (left) valve of articulated specimens.

In addition to the shells, calcified byssal remains are abundant at some levels in the Lower Kimmeridgian at Consolação (south of Peniche) and in the Upper Kimmeridgian at Santa Cruz (west of Torres Vedras), and in the region of Arruda dos Vinhos.

Collection numbers BSP refer to collections of the Bayer. Staatssammlung für Paläontologie und hist. Geologie, Munich ; CSGP refers to the collections of the Serviços Geologicos de Portugal in Lisbon.

III - MORPHOLOGY

Left valve

The abundant left valves are small, usually 10 to 15 mm in height (fig. 1). Most shells are thin (0.5 mm thick), but occasionally shells reach up to 1.8 mm in thickness. Shell outline is very variable, ranging from circular to subquadrate to oval (fig. 2 ; pl. 1, figs. 1-3). The degree of inflation of the valves also varies considerably. Most specimens are weakly to moderately convex ; flat to weakly concave or strongly convex forms (pl. 1, figs. 4,5) are less common. In some specimens, shell growth is very irregular so that the degree of convexity varies greatly in different directions. In these specimens the plane of commissure is undulating.

The umbo is depressed, subterminal (fig. 2 ; pl. 1, fig. 3), rarely terminal (in four specimens, the beak slightly protrudes beyond the dorsal margin). In many specimens a thin, slit-like groove extends from the umbo to the dorsal margin and represents the supradorsal fusion of the valve (pl. 1, fig. 8).

The shell surface is covered with fine to distinct growth lines or growth rugae. Numerous fine, irregular radial threads are present in some specimens, but lacking in others. They vary greatly in strength between specimens and generally become more distinct toward the ventral margin.

Commonly left valves exhibit a circular to oval hole in the umbonal region. This hole does not represent a genuine feature of the shell, but has been caused by abrasion. The umbonal region is particularly prone to abrasion as the shell is very thin in this area due to invariable dissolution of the inner aragonitic layer (see below).

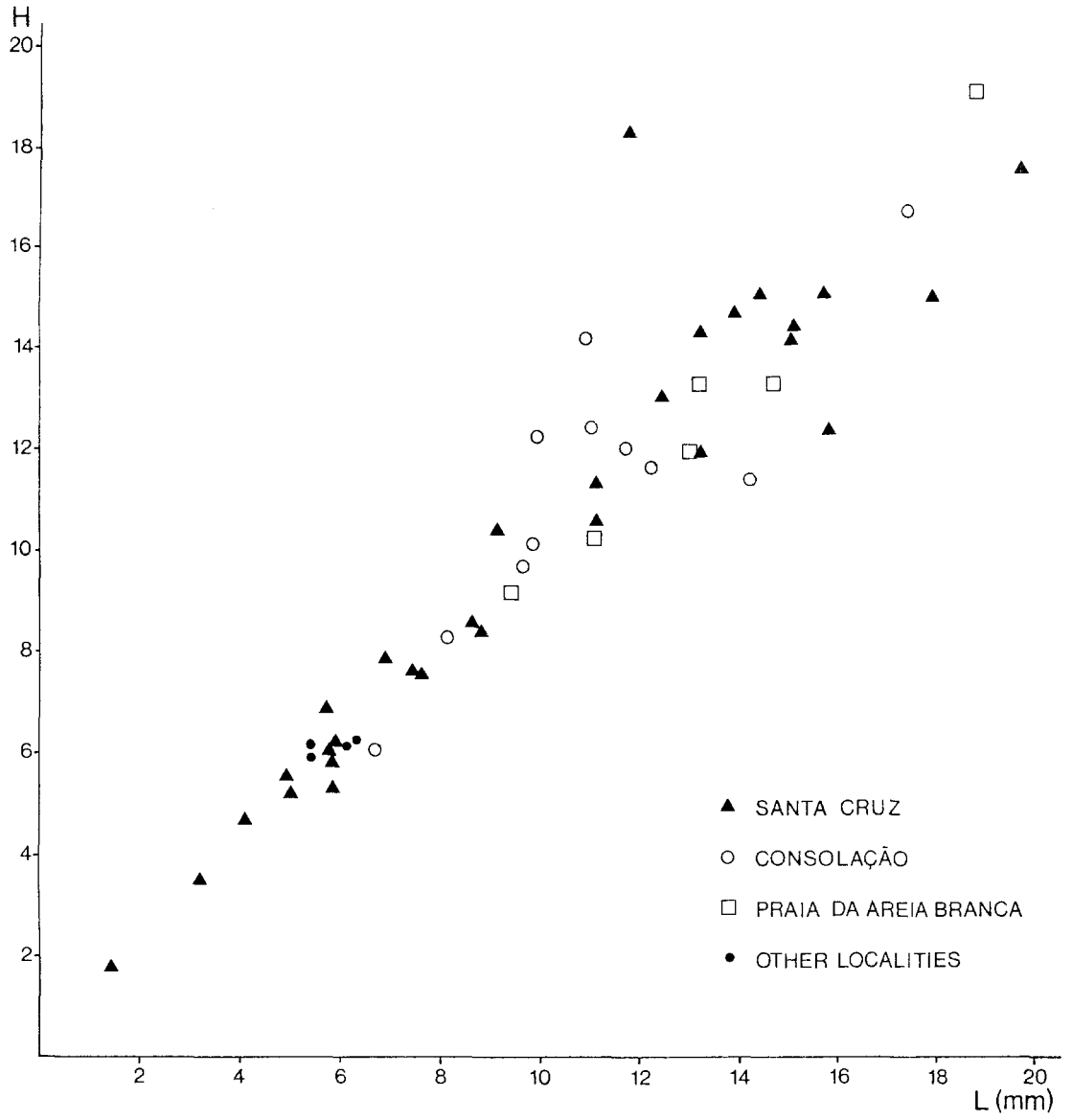


Fig. 1 - Length-height ratio of specimens of *Juranomia calcibyssata*.
Diagramme longueur-hauteur des individus de *Juranomia calcibyssata*.

The interior of the left valve has a triangular resilifer which is particularly well developed in strongly convex specimens (fig. 3), but poorly preserved or missing in other specimens. The resilifer is horizontally striated in some individuals. Most specimens exhibit a shallow, rounded-rectangular depression extending in a dorsoventral direction from the resilifer to slightly beyond the centre of shell (figs. 3,4). It seems probable that the depression represents the site of deposition of the aragonitic complex crossed-lamellar shell layer (Taylor *et alii* 1969) which in most specimens has been dissolved during diagenesis.

Several specimens show the position and shape of muscle scars. They consist of three round to oval interconnected scars (fig. 4 ; pl. 1, figs. 6,7) which occupy a position in the ventral part of the rectangular depression. An additional muscle scar is situated just ventrally to the anterior end of the resilifer.

Right valve

Right valves are only rarely observed. They are very thin and invariably attached to hard substrates. A distinct byssal notch is present in the dorsal part of shell. They have a well developed crus (fig. 5 ; pl. 1, fig. 9) similar to that found in Recent *Ano-*

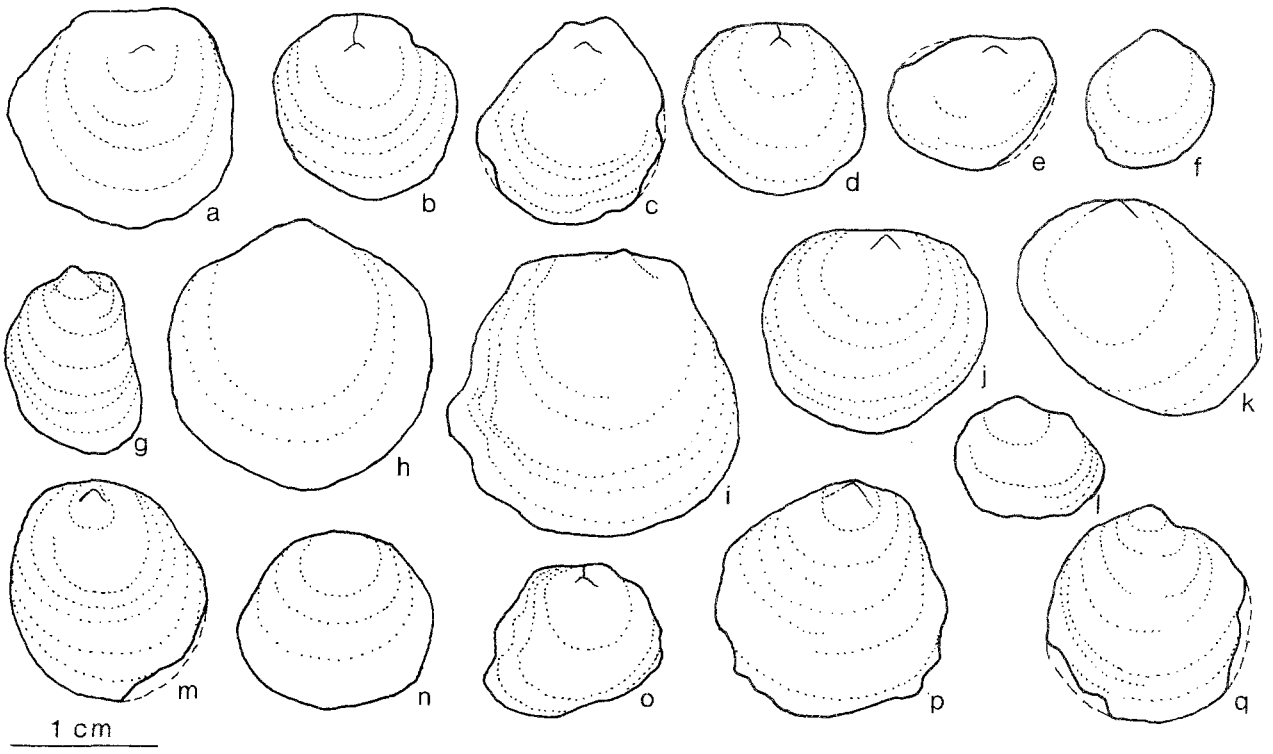


Fig. 2 - **Variation in outline of left (upper) valve of *Juranomia calcibyssata*** ; note the subterminal position of the umbo in most specimens.
Variation morphologique du contour de la valve gauche (supérieure) de *Juranomia calcibyssata*. Remarquer la position subterminale du crochet chez la plupart des individus.

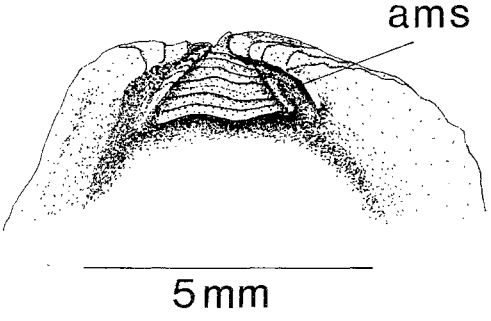


Fig. 3 - **Resilifer and anterior muscle scar (ams) in strongly convex left valve.** Paratype BSP 1984 XXI 1, pl. 1, fig. 4 ; Middle Kimmeridgian of Consolação.
Résilifer et impression musculaire antérieure (ams) d'une valve gauche fortement convexe.

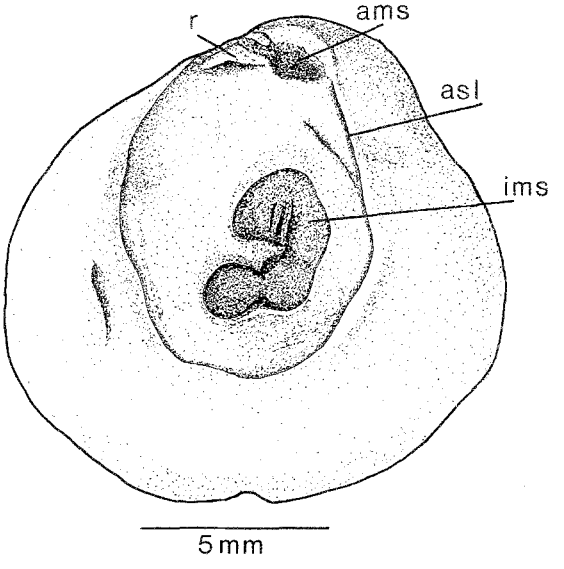


Fig. 4 - **Interior of left valve showing the outline of the aragonitic shell layer (asl), the three interconnected muscle scars (ims), a poorly developed resilifer (r), and the anterior muscle scar (ams).** Paratype BSP 1984 XXII 7 ; Upper Kimmeridgian of Praia Areia Branca.
Face interne d'une valve gauche montrant la surface de la partie aragonitique, les trois impressions musculaires jointes et l'impression musculaire située avant le résilifer. Le résilifer n'est pas développé fortement.

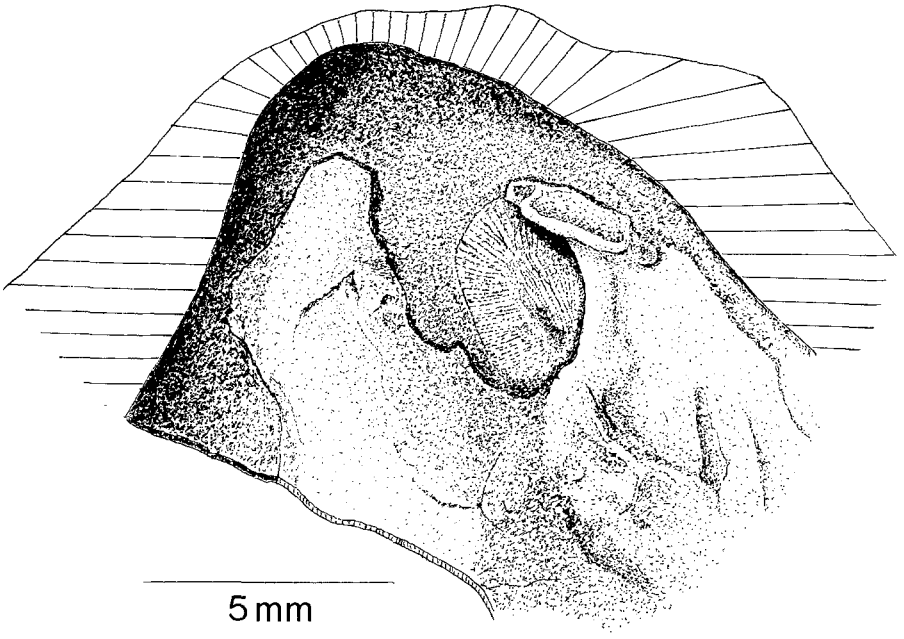


Fig. 5 - Right (lower) valve of ***Juranomia calcibyssata*** attached to the inner surface of ***Myophorella lusitanica*** (SHARPE). Holotype BSP 1984 XXII 1, pl. 1, fig. 9 ; note the large byssal notch, the crus for supporting the ligament, and the remains of the calcified byssus within the byssal notch ; ventral part of shell fragmentary; Upper Kimmeridgian of Santa Cruz.
Valve droite (inférieure) de *Juranomia calcibyssata* fixée à la surface interne de *Myophorella lusitanica* (SHARPE) ; remarquez la grande encoche byssale, le crus pour porter le ligament, et les restes du byssus calcifié dans l'encoche byssale. La partie ventrale de la valve est fragmentée.

mia (where its function is to support the ligament). A subcircular to oval muscle scar is situated ventrally of the byssal notch.

The byssal notch is occupied by a subcircular to oval, finely striated calcitic pad which looks exactly like the calcified byssus of Recent anomiids (pl. 1, fig. 14) and which is therefore interpreted here as the same structure. Such calcitic byssal remains also occur isolated on large shells such as *Isognomon rugosus, Myophorella lusitanica* and *Gervillia sobralensis* (pl. 1, figs. 10-12).

Shell structure

The shell structure of the left valve is foliated, that of the right valve prismatic (figs. 6-9). Originally, the right valve was not cemented to the substrate, but closely adpressed. Only during diagenesis, did the thin cavity between shell and substrate become filled with cement (fig. 8).

IV - DISCUSSION

Several features described above are characteristic of members of the family Anomiidae as defined by Yonge (1977). These include the byssal notch and a crus supporting the ligament in the right valve, and a resilifer and multiple muscle scars in the left valve. Consequently, the specimens from Portugal clearly belong to the Anomiidae. (The other family of the Anomiacea, the Placunidae, possesses unstalked, inverted V-shaped crura which are lacking in our material.). However, the Portuguese speci-

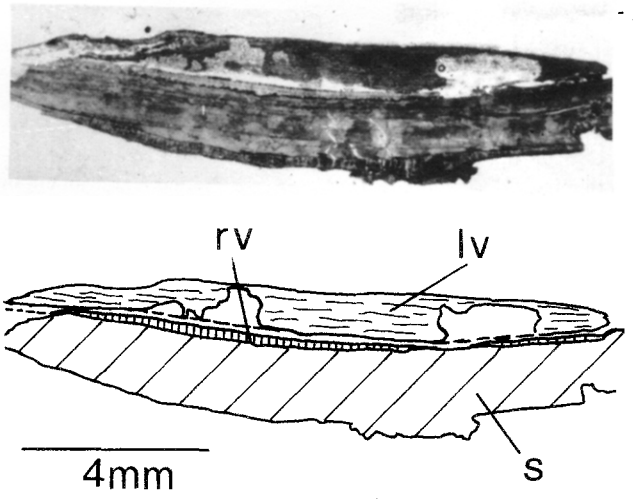


Fig. 6 - Longitudinal cross-section of articulated specimen of ***Juranomia calcibyssata.*** Thin section BSP 1984 XXII 6a ; rv : right (lower) valve ; lv : left (upper) valve ; s : substrate (valve of *Myophorella lusitanica* (SHARPE)) ; apical region on right hand side ; Upper Kimmeridgian of Santa Cruz.
Coupe longitudinale d'un spécimen complet de *Juranomia calcibyssata* ; plaque-mince ; rv : valve droite (inférieure) ; lv : valve gauche (supérieure) ; s : substrat (valve de *Myophorella lusitanica* (SHARPE)) ; région apicale vers la droite.

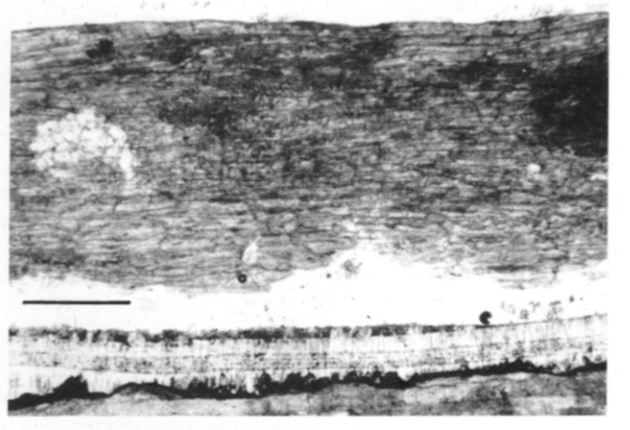


Fig. 7 - **Detail of fig. 6 showing the thick foliated left (upper) valve and the thin prismatic right (lower) valve** ; length of bar 0.5 mm.
Détail de la fig. 6 montrant la valve gauche (supérieure) très épaisse à structure foliée et la valve droite (inférieure) mince à structure prismatique.

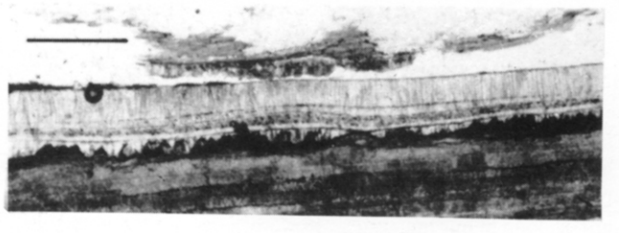
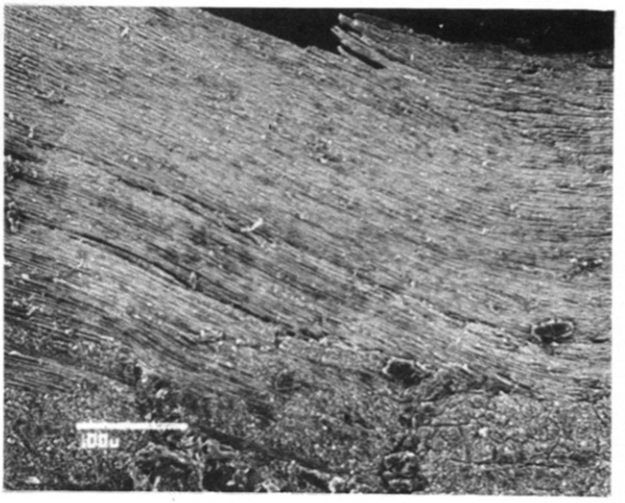


Fig. 8 - **Detail of lower valve.** Note that the valve is not closely adpressed to the substrate. The cavities between valve and substrate are filled with early diagenetic calcite. Thin section BSP 1984 XXII 6b ; Upper Kimmeridgian of Santa Cruz ; length of bar 0.5 mm.
Détail de la valve droite (inférieure). Remarquez que la valve n'est pas fixée par toute sa surface au substrat. Les cavités sont remplies par de la calcite formée pendant la diagenèse.



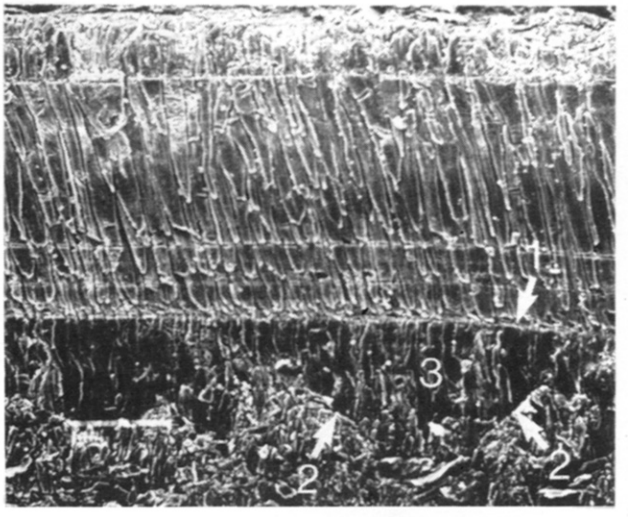


Fig. 9 - a,b - **SEM photographs of the articulated specimen of fig. 6-8** showing the foliated structure of left (upper) valve (a) and the prismatic structure of right (lower) valve (b) ; 1 : lower boundary of right valve ; 2 : irregular surface of substrate (valve of *Myophorella lusitanica* (SHARPE)) ; 3 : cavity filled with early diagenetic calcite ; BSP 1984 XXII 6g ; Upper Kimmeridgian of Santa Cruz ; length of bars 100 µm.
MEB photos montrant la structure foliée de la valve gauche (supérieure) (a) et la structure prismatique de la valve droite (inférieure) (b) ; 1 : base de la valve droite ; 2 : surface irrégulière du substrat (valve de *Myophorella lusitanica* (SHARPE)) ; 3 : cavité entre la valve droite et le substrat remplie de calcite.

mens cannot be accommodated in any of the existing anomiid genera. The morphology of their hard parts reveals features characteristic of both Recent *Anomia* and *Patro*. They differ from the former in possessing three interconnected muscle scars in the left valve, in addition to a distinct anterior pedal retractor muscle scar situated just ventrally of the anterior end of the resilifer. The former can be interpreted as the scars of the adductor and the barely split byssal retractors. In *Anomia,* by contrast, the adductor and divided byssal retractors are well separated. Furthermore, right valves of *Anomia* do not possess, apart from the aragonitic prismatic myostracum, a prismatic shell structure (Taylor *et alii* 1969, Yonge 1980), which is clearly seen in our material.

The Portuguese specimens are like *Patro* with respect to the prismatic shell structure of the right valve (Beu 1967) and the shape of the crus. Probably, the well developed prismatic layer corresponds to the outer calcitic prismatic layer of some pteriacean bivalves and is therefore most likely of calcitic origin. However, differences exist between *Patro* and the Portuguese material in the complete supradorsal fusion of shell and ligament of the left valve in *Patro,* as compared with the thin slit present between umbo and dorsal margin of our specimens. Moreover the latter do not show the near-vertical arrangement of muscle scars of *Patro.*

The Jurassic anomiid *Eonomia* possesses, in the right valve, a thin (calcitic) prismatic layer which covers a conspicuous layer of calcite folia (Fürsich & Palmer 1982, p. 898). The latter does not exist in the Portuguese specimens. Additionally, *Eonomia* differs in having symmetrical crura, a cemented right valve, and a byssus which probably was not calcified.

As our material cannot be accommodated in any of the available genera, the new genus *Juranomia* is proposed.

V - TAXONOMY

Family **Anomiidae** RAFINESQUE, 1815

Genus ***Juranomia*** gen. nov.

TYPE-SPECIES :

Juranomia calcibyssata sp. nov.

DERIVATIO NOMINIS :

After Jurassic and *Anomia*.

DIAGNOSIS :

Shell inequivalve. Right valve with large byssal notch and well developed crus. Single subcircular adductor scar placed ventrally of byssal notch. Left valve with triangular resilifer, anterior pedal retractor scar and three interconnected scars. Supradorsal fusion of shell marked by thin slit. Right valve not cemented ; shell attached to substrate by means of calcified byssus. Shell structure of right valve prismatic, that of left valve foliated. Myostracum of both valves aragonitic, remainder of shell calcitic.

REMARKS :

Shape and external features of the left valve of *Juranomia* are very similar to that of many species of *Placunopsis* MORRIS & LYCETT, 1853. However, the internal features of *Placunopsis* are poorly known (partly probably a result of diagenetic dissolution of an inner aragonitic shell layer). Morris & Lycett (1853, p. 5, pl. 1, fig. 8) describe a possibly bilobed muscle scar in *Placunopsis jurensis (=P. fibrosa* LAUBE, 1867) from the Middle Jurassic of England. If true, this feature would serve to distinguish the two genera, *P. fibrosa* being the type species of *Placunopsis.*

According to several authors (e.g. Morris & Lycett 1853, p. 5 ; Arkell 1929, p. 49 ; Freneix in Freneix *et alii* 1986, p. 24) the right valves of *Placunopsis* are cemented to the substrate and do not possess a byssal notch or foramen. This feature would be sufficient to separate *Placunopsis* species from *Juranomia.* However, it is possible that these *Placunopsis* valves, in fact, represent flat to even slightly concave left valves rather than right valves. As a result right valves of Jurassic *Placunopsis* could be virtually unknown. Only with well preserved material of the type species *Placunopsis fibrosa* LAUBE, 1867, might the relationship between *Placunopsis* and *Juranomia* be clarified.

Juranomia calcibyssata sp. nov.
figs. 1-9 ; pl. 1, figs. 1-13

1981 - *Placunopsis suprajurensis* (BUVIGNIER) ; Fürsich, fig. 6B.
1986 - *Anomia suprajurensis* (BUVIGNIER) ; Fürsich & Werner, p. 281, 283, 285.

HOLOTYPE :

BSP 1984 XXII 1 (right valve) from the Upper Kimmeridgian (Pteroceriano facies) of Santa Cruz, west of Torres Vedras, Estremadura (Portugal).

PARATYPES :

BSP 1984 XXII 1-8, BSP 1984 XXI 1-3, CSGP 4183-4185.

DERIVATIO NOMINIS :

After the calcified byssus of the species.

DIAGNOSIS :

Small to medium-sized *Juranomia* with orbicular to subrectangular outline, and a height-length ratio close to 1. Surface of left valve covered with faint radial, somewhat irregular riblets which may be absent in some specimens.

REMARKS :

Juranomia calcibyssata is very variable in shape and ornamentation, and there are numerous species described from Upper Jurassic rocks which are effectively indistinguishable from *J. calcibyssata* with regard to the external morphology of the left valve. Most of these species have been assigned to either *Anomia* or *Placunopsis* (table 1). In these species only the left valve is known. Where the interior of the left valve is seen, diagnostic features such as muscle scar(s), hinge, and ligament are lacking, most likely due to diagenetic dissolution of an inner aragonitic shell layer. Nothing is known about the right valves of these species. As a consequence, the relationship between these species and *J. calcibyssata* cannot be established until well preserved material of the former becomes available. It is very likely, that at least some of these poorly known species are senior synonyms of *J. calcibyssata*. However, it seems appropriate to keep the well documented Portuguese form separate to avoid unnecessary confusion.

The lack of right valves of Jurassic *Placunopsis/Anomia* species and the scarcity of right valves of *J. calcibyssata* requires an explanation. In the case of *J. calcibyssata* the lower right valve is very thin and primarily not cemented to the substrate. Fixation of the shell took place via the calcified byssus which connected the upper left valve to the substrate. Possibly most of the lower right valve consisted of aragonite, the dissolution of whichearly on during diagenesis furthermore increased the frailty of the valve. After death of the animal and after decay of the organic material, both valves became detached and the very fragile right valve was subsequently destroyed by biostratinomic processes. This was facilitated by the prismatic shell structure which disintegrates more easily than a foliated structure. Only in cases where both valves of *J. calcibyssata* are preserved in life position (apparently as a result of rapid burial and by diagenetic cementation of the lower valve to the substrate (figs. 8, 9b) is the lower right valve preserved, and can be studied after the upper left valve has been carefully removed. [A similar mode of preservation is mentioned in *Anomia ponticulana* from the Cenomanian Woodbine Formation of Texas by Stephenson (1952, p. 81)].

Placuna jurensis sp. nov ; Roemer 1836, p. 66, pl. 16, fig. 4.
Anomia raulinea sp. nov. ; Buvignier 1852, p. 26, pl. 20, figs. 22-24.
Anomia raulinea BUVIGNIER ; Thurmann & Etallon 1863, p. 282, pl. 40, fig. 8.
Anomia suprajurensis sp. nov. ; Buvignier 1852, p. 26, pl. 20, figs. 16-21.
Anomia suprajurensis BUVIGNIER ; Loriol & Pellat 1866, p. 117, pl. 11, figs. 6-7 ; Loriol & Cotteau 1868, p. 214, pl. 14, fig. 6 ; Loriol & Pellat 1875, p. 387, pl. 25, figs. 2-6 ; (?)Alth 1882, p. 298, pl. 27, figs. 17-18 ; Fiebelkorn 1893, p. 398, pl. 14, fig. 6.
Anomia nerinea sp. nov. ; Buvignier 1852, p. 26, pl. 20, figs. 16-21.
Anomia nerinea BUVIGNIER ; Thurmann & Etallon 1863, p. 282, pl. 40, fig. 6 ; Loriol 1888, p. 331, pl. 37, figs. 2-4 ; Cossmann 1922, p. 6, pl. 5, figs. 12-13.
(?)*Anomia undata* sp. nov. ; Contejean 1860, p. 324, pl. 24, fig. 8.
Anomia jurensis ROEMER ; Boehm 1881, p. 185, pl. 40, fig. 8.
Anomya numismalis sp. nov. ; Moesch 1867, p. 310, pl. 4, fig. 1.
(?)*Pholas pseudochiton* sp. nov. ; Contejean 1860, p. 306, pl. 24, figs. 5-6.
Posidonia suprajurensis sp. nov. ; Contejean 1860, p. 306, pl. 24, figs. 5-6.
Orbicula ? radiata sp. nov. ; Phillips 1829, p. 130, pl. 4, fig. 12.
Placunopsis radiata (PHILLIPS) ; Arkell 1929, p. 49, pl. 3, figs. 4-5, p. VII ; Freneix in Freneix *et alii* 1986, p. 25, pl. 1, figs. 1-3 ; pl. 2, figs. 1-4.

Table 1 - List of Jurassic species of *"Anomia"/"Placunopsis"* with left valves similar in outline and ornamentation to that of *Juranomia calcibyssata* sp. nov.

In contrast to the scarcity of right valves, calcified byssal pads (pl. 1, figs. 10-13) are common on other, large, bivalve shells. These are, however, never surrounded by lower right valves, supporting our opinion that the right valves were not primarily cemented to the substrate. The good preservation of the calcified byssus suggests that it consisted, unlike the byssus of Recent *Anomia ephippium* (see Pujol *et alii* 1970) of calcite rather than aragonite.

VI - PALAEOECOLOGY

Juranomia calcibyssata is very widespread in the Kimmeridgian of the Lusitanian Basin. It occurs predominantly in fine-grained siliciclastic sediments (silt, marly to fine-sandy silt) which represent nearshore to marginal marine environments such as bays and lagoons (e.g. Pteroceriano, Alcobaça Beds). Rarely it is found in basinal sediments of the Abadia Formation.

The species attached itself primarily to large shells such as *Isognomon rugosus, Myophorella lusitanica, Gervillia (Gervillella) aviculoides*, and *Gervillia (Virgellia) sobralensis*. Colonisation took place either post-mortem (e.g. in the case of the shallow infaunal *Myophorella*) or while the host was alive (e.g. in the case of many semi-infaunal *Isognomon* where colonisation was restricted to the part of shell projecting above the sediment - water interface).

The great variability of shape and ornamentation of the species is largely a result of the substrate, to which the shell was closely adpressed. Commonly therefore, upper left valves exhibit allomorphic growth.

J. calcibyssata (described as *Anomia suprajurensis*) is a member of several benthic associations (Fürsich & Werner 1986) such as the *Anomia suprajurensis-Protocardia peraltaensis* association, the *Lycettia poikilohalina-Anomia suprajurensis* association, and the *Isognomon rugosus-Anomia suprajurensis* subset. These associations lived largely in brackish (brachy-to mesohaline) environments and in many of them *J. calcibyssata* must have been subjected to wide salinity fluctuations. It can therefore be regarded as an euryhaline opportunitic species (Fürsich & Werner 1986, p. 318) which flourished when environmental conditions were unsuitable for most other benthic molluscs.

VII - COMPARISON WITH OTHER MESOZOIC TO RECENT ANOMIIDS

The salinity tolerance of *J. calcibyssata* is typical also of many Recent anomiids such as *Anomia ephippium* LAMARCK (Fischer-Piette 1931), *A. patelliformis* LAMARCK (e.g. Sorgenfrei 1958) and *A. squamula* LAMARCK (Johansen 1918). Studies of Upper Cretaceous brackish environments of the Western Interior Seaway (Fürsich, unpublished data) show, that there, too, anomiids (e.g. "*Anomia*" *ponticulana* STEPHENSON, "*Anomia*" *propatoris* HAYDEN, and "*Anomia*" *gryphorbyncha* WHITE) are common elements of the benthic associations.

What has been said about the preservation potential of lower right valves of *J. calcibyssata* is probably also true of these Cretaceous species : only convex upper valves and calcified byssal pads are known and most likely, these species had, like *J. calcibyssata*, only a very thin and predominantly aragonitic lower right valve.

Huckriede (1967, p. 64) gives further examples of the occurrence of species of "*Anomia*" in brackish environments of the Cretaceous and Tertiary. It appears, therefore, that in addition to occurring in fully marine environments, anomiids successfully colonised marginal marine environments of reduced salinity from late Jurassic times onwards. Here they formed important constituents of the benthic communities.

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PLATE

PLATE 1

Juranomia calcibyssata, gen. et sp. nov.

Fig. 1 : Left (upper) valve. Paratype CSGP 4184 ; Upper Kimmeridgian of Praia Areia Branca ; x 2.
Valve gauche (supérieure).

Fig. 2 : Left valve with subquadratic outline. Paratype CSGP 4185 ; Upper Kimmeridgian of Praia Areia Branca ; x 2.
Valve gauche à forme subquadratique.

Fig. 3 : Left valve with subterminal umbo. Paratype BSP 1984 XXII 3 ; Upper Kimmeridgian of Santa Cruz ; x 2.
Valve gauche avec un crochet subterminal.

Fig. 4 : Strongly convex left valve. Paratype BSP 1984 XXI 1 ; Middle Kimmeridgian of Consolação ; x 2.
Valve gauche d'une convexité très forte.

Fig. 5 : Strongly convex specimen of *Juranomia calcibyssata* growing on top of another, moderately convex specimen. Paratype BSP XXII 2 ; Upper Kimmeridgian of Santa Cruz ; x 2.
Individu fortement convexe attaché à un autre individu d'une convexité faible.

Fig. 6,7 : Interior of left (upper) valves showing the triangular resilifer, the rectangular depression with three interconnected muscle scars, and an additional muscle scar anterior of the resilifer. Paratypes ; Upper Kimmeridgian of Praia Areia Branca ; fig. 6 : CSGP 4181 ; x 2 ; fig. 7 : CSGP 4185 ; x 4.
Faces internes de valves gauches (supérieures) montrant la cavité rectangulaire avec trois impressions musculaires jointes et une impression musculaire avant le résilifer triangulaire.

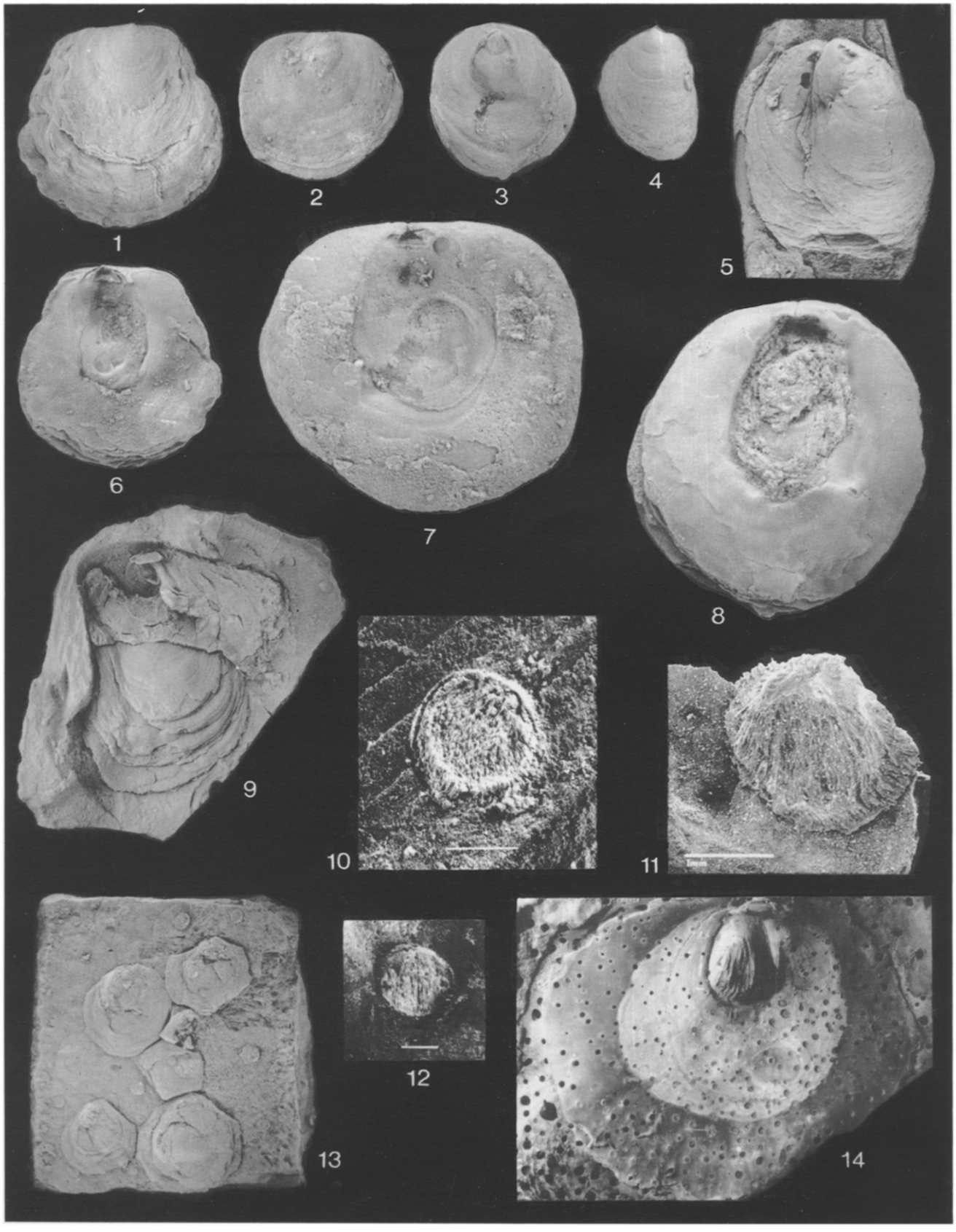
Fig. 8 : Interior of left valve ; dorsal margin with supradorsal fusion. Paratype BSP 1984 XXII 3 ; Upper Kimmeridgian of Santa Cruz ; x 4.
Face interne de valve gauche (supérieure) ; le bord dorsal interrompu par la fusion supradorsale.

Fig. 9 : Right (lower) valve attached to the inner surface of *Myophorella lusitanica* (SHARPE) and partly to another specimen of *Juranomia calcibyssata*. Holotype BSP 1984 XXII 1 ; Upper Kimmeridgian of Santa Cruz ; x 2.
Valve droite (inférieure) attachée à la surface interne de *Myophorella lusitanica* (SHARPE) et en partie à un autre individu de *Juranomia calcibyssata*.

Fig. 10-12 : Pads of calcified byssus of *Juranomia calcibyssata* ; **fig. 10** : byssus fixed to a valve of *Isognomon rugosus* (MÜNSTER) ; BSP 1984 XXII 8 ; Upper Kimmeridgian of Santa Cruz ; length of bar 2 mm. **fig. 11** : SEM photograph ; BSP 1984 XXI 3 ; Middle Kimmeridgian of Consolação ; length of bar 1 mm. **fig. 12** : byssus fixed to the inner surface of the oyster *Praeexogyra pustulosa* (SHARPE) ; BSP 1984 XXI 2 ; Middle Kimmeridgian of Consolação ; length of bar 1 mm.
Coussins de byssus calcifié de *Juranomia calcibyssata ;* **fig. 10** : byssus fixé à une valve de *Isognomon rugosus* (MÜNSTER). **fig. 11** : photo MEB, **fig. 12** : byssus fixé à la surface interne d'une valve de l'huître *Praeexogyra pustulosa* (SHARPE).

Fig. 13 : Specimens of *Juranomia calcibyssata* and remains of calcified byssus attached to a piece of crocodile plate ; CSGP 4183 ; Pteroceriano (? Upper Kimmeridgian), south of Santa Cruz ; x 1.
Spécimens de *Juranomia calcibyssata* et restes du byssus calcifié attachés à un morceau d'une plaque de crocodile.

Fig. 14 : Right (lower) valve of *Anomia simplex* d'ORBIGNY with well developed calcified byssus ; interior view ; aragonitic parts of shell are light coloured ; Recent ; Wachapreague tidal channel ; New England ; x 1.5.
Face interne d'une valve droite (inférieure) de *Anomia simplex* d'ORBIGNY attachée à un substrat dur. Coussin du byssus calcifié bien développé ; la zone de couleur claire autour de l'encoche byssale indique les parties aragonitiques de la valve.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